

Characteristics of Massachusetts' CRT Recycling Program

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Executive Summary

- This report characterizes the municipal recovery system developed in Massachusetts to handle discarded cathode ray tubes (CRTs) from computer monitors and televisions. Our research focuses on the development and operation of the Massachusetts system and lessons that can be learned from it.
- Massachusetts' Department of Environmental Protection (DEP) identified the growth of CRTs and electronics in the waste stream as a priority in the late 1990s. DEP took action to:
 - Remove the hazardous waste stigma from used electronics by exempting them from regulation as a hazardous waste if they are handled intact
 - Ban the disposal of CRTs in Massachusetts landfills and incinerators
 - Provide economic incentives for the establishment of a collection and recovery system

Data Analysis

- 94% of Massachusetts residents live in communities with CRT recycling programs in place.
 - 56% have access to various types of dropoff programs
 - 14% have access to curbside collection
 - 24% have access to both curbside and dropoff

- We estimate that municipal programs recover 7.2 million pounds of CRTs annually or approximately 180,000 TVs and computer monitors.
 - The weight data reflect products that contain CRTs (*e.g.*, monitors or TVs) rather than only the tube itself. In general, we have reported the information by weight since the data were compiled that way.
 - To convert to units, we applied typical weight assumptions and estimated that 110,000 TVs and 70,000 computer monitors are recovered annually.
- DEP's grant program has supported the recovery of 7 million pounds of CRTs over the past three years. This is only a portion of total CRT recovery which also includes other municipal programs not receiving grants plus business recycling.
- Municipal programs capture about 1.2 pounds of CRTs per resident currently. Average recovery did not vary significantly between communities relying primarily on dropoff and those using primarily curbside.
- We estimate that the cost of operating municipal programs is between \$1.7 million and \$2.8 million per year or between \$0.72 and \$1.20 per household. Costs to set up the municipal programs in Massachusetts totaled less than \$1 million.
 - Municipal programs typically cost less than \$1,000 to set up.
 - Operating costs per ton were lowest in communities relying primarily on curbside collection, because these communities handled the most material.
- The practice of charging fees to residents, by itself, does not appear to have much impact on cost or effectiveness. In fact, dropoff programs that charged fees were actually somewhat more effective, measured in pounds recovered per resident.

1. Introduction and Background

- This report characterizes the municipal recovery system developed in Massachusetts to handle discarded cathode ray tubes (CRTs) from computer monitors and televisions. Massachusetts' system provides a large-scale model for observing the operations of a recovery system for residential and small business CRTs and has successfully accommodated a large increase in the amount of CRTs diverted from disposal.
- Our research focuses on the development and operation of the Massachusetts system and lessons that can be learned from it. For context, this chapter provides limited background on CRTs and their management, but this is not an exhaustive review of those issues.

1.1 Background on CRTs

- Consumer electronics, of which CRTs are a part, are described as a “fast-growing segment of the MSW [municipal solid waste] stream” in EPA’s most recent national waste report.¹ Rapid growth in the sales of personal computers has led to an increase in the number of computer monitors in circulation. Some have also expressed concern over the solid waste implications of the pending conversion from analog to digital, high-definition TV.
- EPA does not track CRT generation and recovery separately, but does track consumer electronics as a category. EPA estimates that all consumer electronics account for 0.9% of MSW. Recovery rates range from virtually 0 for audio products (radios, CD players) to 21% for information products (PCs, monitors, telephones, printers).²

¹ “Municipal Solid Waste in the United States: 2000 Facts and Figures,” EPA Office of Solid Waste, June 2002, Appendix C.

² *Ibid.*

- Massachusetts estimates that 25,000 tons of CRTs (*i.e.*, products like monitors and TVs that contain CRTs, not the tubes themselves) go out of service each year. This does not mean that they enter the waste stream, but simply that they are no longer used. About half of these are assumed to come from residential sources. An estimated 3,000 tons of CRTs were actually disposed of statewide in 1998, with the rest destined for reuse, repair, or storage.³
- CRTs pose unique waste management challenges because of their composition and the unpredictability of how and when they enter the waste stream.
 - CRTs contain lead in the glass and solder used to encase the tube. A computer monitor, for example, contains about four pounds of lead. It is this lead content which raises concern over landfilling or incinerating discarded CRTs.
 - A second challenge is the “stockpiling” of old CRTs by consumers and businesses. Because of rapid technical innovation, older CRTs get replaced by newer ones, but people are loathe to get rid of the old ones, feeling that they may still be valuable. Surveys show that many CRT owners have multiple CRTs “stored” at home or in offices and are more likely to store or give away old equipment than discard it.⁴ Even more so than for other durable goods, projecting when and how much of the material will enter the waste stream is extremely difficult.
- The crux of the issue is that consumers and businesses are holding a growing inventory of CRTs that will some day require proper management.

³ “DEP’s 1998 CRT/Electronics Recycling Strategy: Infrastructure Development Plan,” Massachusetts Department of Environmental Protection, May 1, 1998.

⁴ “Electronics Re-Use and Recycling Infrastructure Development in Massachusetts,” EPA Region 1, September 2000, Attachment 5.

1.2 Background on CRT Recovery

- Many recovery options are available for CRTs. The option selected depends on the inherent value of the equipment and access to facilities and infrastructure.
 - The highest value option, both from an economic and waste management standpoint, is reuse. Many discarded CRTs are not defective; they may simply have been replaced with newer or better equipment.
 - Some broken TVs and monitors can be repaired and resold profitably, but special expertise is required to assess and repair the equipment. Repairing a small fraction of recovered equipment can significantly improve the economics of recovery. Export markets are often the best option for selling reconditioned equipment.
 - Even if it cannot be resold, refurbished equipment may be donated for use in schools or other similar settings.
 - For reuse to occur, businesses and consumers need access to repair or re-use services and must be educated that the services are available.⁵
 - The next tier in the hierarchy is recovery of CRT parts and components for reuse and resale. This, too, requires special expertise. Sometimes it is more economical to export intact CRTs for dismantling and parts recovery overseas.
 - An alternative form of recovery is to extract marketable materials from the CRTs. Processing facilities may dismantle CRTs and remove the CRT glass as well as plastics and metals that can be sold. Again, export markets are important since selling units to be dismantled abroad may be more profitable for recyclers than handling them in the US.⁶ Other facilities pulverize the equipment and smelt off the recoverable metals.

⁵ Businesses often have access to the asset recovery services offered by equipment vendors. When computers go off-lease or are upgraded, some suppliers manage the old equipment through either a captive or third party system for reuse and recovery.

⁶ Exports can create environmental problems, however, since not all overseas customers handle hazardous components appropriately.

2. Massachusetts' Approach to CRT/Electronics Recycling

- Massachusetts' Department of Environmental Protection (DEP) identified the growth of CRTs and electronics in the waste stream as a priority in the late 1990s. The combination of growing sales of new products and the accumulating inventory of old equipment presented a waste management challenge for which the Department wanted to prepare.
- DEP identified several problems to address:
 - Recovery infrastructure was limited, especially for residential-source material. Commercial generators, in contrast, had more options available. In addition to asset recovery programs offered by vendors, DEP identified 48 electronics recycling companies that would pick up used equipment from businesses in Massachusetts.
 - Old equipment piling up in storage had limited value. With increasing age, reuse and repair become impractical. Therefore DEP assumed that when the material did come out of storage, it would be likely to enter the conventional waste stream with other bulky wastes.
 - The threat of hazardous waste regulation hung over firms that managed electronics and CRTs. Companies would be required to handle these components like hazardous waste, shouldering the enormous expense and stigma accompanying that designation. Few firms would be willing or able to enter the electronics recovery market if it meant compliance with hazardous waste regulations.
- DEP's response was a regulatory one (no new statutory authority was required) that addressed many of these issues. A regulatory approach was the most practical and expedient for DEP to follow. The three main initiatives were:

- **Remove the hazardous waste stigma from used electronics** by exempting them from regulation as a hazardous waste if they are handled intact.
 - Community programs and private haulers could collect and store TVs, computers, or other electronic equipment without obtaining any special permits or regulatory status. This seemed a particularly sensible course of action since intact units, which comprise the bulk of waste products, pose no environmental risk.⁷
 - The initiative significantly lowered the barrier to entry for new entrants into the recycling business and made it possible for any public or private facility to act as a collection and storage point for these materials.

- **Ban the disposal of CRTs in Massachusetts landfills and incinerators.**
 - DEP had previously used its regulatory authority to ban tires, car batteries, and major appliances (white goods) from these facilities. This meant that operators of approved disposal facilities were required to examine loads for these banned materials and remove them from incoming loads before burning or burying them.
 - This element of the program provided the motivation for communities and waste haulers to offer diversion programs for CRTs to keep them from contaminating loads and driving up waste disposal costs.
 - Like the hazardous waste exemption, this initiative had no direct impact on individual consumers, but it did lay the groundwork for greater access to recovery programs.

- **Provide economic incentives for the establishment of a collection and recovery system** to serve the residential market. DEP sought to promote voluntary “front-end” collection of CRTs, prior to their co-mingling with other trash, in order to protect the value of the commodities.
 - DEP proposed a combination of voluntary municipal, not-for-profit, and private sector efforts (the collection system is explored in much greater detail in the next chapter).
 - The agency specifically rejected mandatory recovery, retailer take-back, and deposit systems because of their inflexibility and high cost.⁸

⁷ By comparison, many other household materials pose much greater risk from mismanagement. Paints, used oil, pesticides, and other household chemicals could do significant environmental damage if mismanaged (disposed of down a drain or storm sewer, for example).

⁸ See Note 3, page 4.

- DEP promoted collection efforts by subsidizing the cost of recycler processing. The State established contracts with two recycling companies to handle CRTs at set prices, developed an assistance program for interested cities and towns, and paid the recyclers' fees for all CRTs recovered from those municipalities for one year. DEP *did not* pay for the recovery *all* CRTs in the state, only those from communities awarded grants.
- This subsidy element represented a departure from previous state efforts to promote recycling.
 - While the state had previously combined disposal bans with support for new recycling infrastructure, the support historically took the form of up-front grants to establish programs or purchase equipment. The state had explicitly not provided operating support for programs on the grounds that the programs would need to support operating costs in order to be self-sustaining after the state was no longer involved.
 - The rationale for a different approach in this case was the hope that offering low or no-cost recycling to residents would help clear out the inventory of old CRTs in basements and attics.
 - Also, the start-up costs were limited so the processing costs were the most important and practical program element to subsidize.
- The next chapter describes how the municipal collection system actually developed as well as its effectiveness and cost.

3. CRT Recycling Program Data Analysis

3.1 Summary

- 94% of Massachusetts residents live in communities with CRT recycling programs in place.
 - 56% have access to various types of dropoff programs
 - 14% have access to curbside collection
 - 24% have access to both curbside and dropoff
- We estimate that municipal programs recover 7.2 million pounds of CRTs annually or approximately 180,000 TVs and computer monitors. Assuming that the waste bans are highly effective, this is a reasonable estimate for current CRT waste generation as well.
 - The weight data reflect products that contain CRTs (*e.g.*, monitors or TVs) rather than only the tube itself. In general, we have reported the information by weight since the data were compiled that way.
 - To convert to units, we applied typical weight assumptions and estimated that 110,000 TVs and 70,000 computer monitors are recovered annually.
- DEP's grant program has supported the recovery of 7 million pounds of CRTs over the past three years. This is only a portion of total CRT recovery, which also includes other municipal programs not receiving grants and business recycling.
- Municipal programs capture about 1.2 pounds of CRTs per resident currently. Average recovery did not vary significantly between communities relying primarily on dropoff and those using primarily curbside.

- We estimate that the cost of municipal programs is between \$1.7 million and \$2.8 million per year or between \$0.72 and \$1.20 per household. Costs to set up the municipal programs in Massachusetts totaled less than \$1 million.
- Municipal programs typically cost less than \$1,000 to set up. Though set up is more expensive for curbside, the higher tonnage handled gives curbside the lowest set-up costs per ton.
- Annual operating costs are highest for curbside, reflecting the relatively large amount of material handled in those programs. The larger scale for these programs gives curbside the lowest operating costs per ton.
- The practice of charging fees to residents, by itself, does not appear to have much impact on cost or effectiveness. In fact, dropoff programs that charged fees were actually somewhat more effective, measured in pounds recovered per resident.

3.2 System Overview

3.2.1 Residential Program Description

- **Municipal dropoff facilities:** Located at municipal transfer stations or similar locations, these programs are the most common way of providing access to recycling for residents.
 - The primary requirements for these programs are space for storage (covered, preferably), arrangements for transportation and recovery of the material by a hauler or recycler, and administrative controls to monitor incoming items and to collect fees (if any). Since CRTs represent one of several “bulky” materials that are handled this way (*e.g.*, car batteries, white goods), little new infrastructure or labor is required.

- Municipal dropoff programs may be either ongoing (*i.e.*, CRTs may be dropped off during regular hours for the facility or at least on a regular basis like every Tuesday and Saturday) or periodic special events. In some cases, communities contract with haulers or recyclers to offer collection days two or three times a year. This is similar to a household hazardous waste collection day and in some cases CRTs collections are run concurrently with them.
- Some communities direct residents to private facilities (owned by waste haulers or recyclers), but there are relatively few of these.
- **Non-profit dropoff facilities:** Massachusetts has seven Permanent Regional Facilities or PRFs to which municipalities can direct their residents. Goodwill Industries operates three PRFs in Lowell, Pittsfield, and Springfield; the Salvation Army operates three in Saugus, Worcester, and Springfield; and the seventh is operated by the University of Massachusetts at its main campus in Amherst.
 - The charity-based PRFs predate the state's program in that these organizations have long accepted used equipment as donations to be subsequently re-sold through their retail outlets ("thrift shops"), but before the program the programs only accepted working equipment.⁹
 - Where the PRF has a contract with a municipality, it will accept all CRTs from those communities.
 - In other cases, the charity PRFs are more selective, sometimes only accepting functioning CRTs for re-sale. The charities differ in their fee policies: some will not charge a fee and therefore only accept working equipment; others will accept any CRT, but charge a fee to cover their costs.

⁹ One original objective of the charity-based programs was to use workers at the charity facilities to evaluate and repair or upgrade equipment for resale. In fact workers at some of the facilities were trained, but the task proved to be beyond the workers and the charities could not cover their costs.

- **Curbside collection** of CRTs with other bulky wastes
 - Larger cities in particular already offer periodic collection of bulky items at the curb, either on a regular pickup schedule or an on-call basis.
 - Communities vary in their fees for these programs, sometimes requiring purchase of a sticker to place on the item and other times including the cost of pickup in other trash or recycling fees. Collected items are either transported to a recovery facility or off-loaded at a municipal facility and then picked up by a hauler or recycler.

3.2.2 Summary Statistics

- 82% of Massachusetts cities and towns (289 communities) offer some type of CRT recycling program for residents (Exhibit 3-1).^{10 11} Virtually all of them fall into some combination of the program types described above. Many residents have multiple options for CRT recovery.

Exhibit 3-1

Massachusetts Municipal CRT Recycling Programs*

	Number of Programs	% of Towns	% of Population	% Charging Fees**
Dropoff*** Only (Town or Private)	229	65%	53%	37%
Charity Dropoff Only	23	7%	3%	61%
Curbside Only	23	7%	14%	26%
Curbside and Dropoff	14	4%	24%	43%
No Program	62	18%	6%	--
Totals	351	100%	100%	38%

*From DEP database of municipal programs updated in early 2002. Totals may not add because of rounding.

** Percentage of towns with programs that charge a fee

*** Ongoing and special event dropoff are combined.

¹⁰ Statistics on municipal programs were derived from a Massachusetts DEP database which DEP staff updated in early 2002. We appreciate the willingness of Greg Cooper and Brooke Nash at DEP to share this and other information analyzed later in the report.

¹¹ We should note that many of these programs are available to small businesses as well.

- These cities and towns contain 94% of the state's population, so only 6% of residents live in a community without a formal program. (The average population of the towns with no program is only 6,000). Of course these residents can use the charity dropoff facilities or other private dropoff programs that are offered by electronics manufacturers and retailers.
- The most common program is dropoff, found in 229 Massachusetts communities containing 53% of the population. Most of these are ongoing programs, but the data do not clearly distinguish between ongoing and special event programs. Of the municipal dropoff programs, 37% charged a fee to residents for CRT recycling.
- Communities that direct residents to nearby charity centers are the next most common (23 towns), but they serve only 3% of the population. These programs are the most likely to charge fees (61%).
- 23 towns offer only curbside pickup. These contain 14% of the population and include some of the larger Boston suburbs.
- The largest cities plus several other communities offer both curbside and dropoff programs (as they do with other recyclables). These 14 cities and towns contain 24% of the state's residents and include the state's three largest cities (Boston, Worcester, and Springfield).

3.3 Recovery Data

Exhibit 3-2

3.3.1 Analysis of DEP Data

Massachusetts' CRT Recycling Grant Program*

- During the three years of its grant program, DEP has supported recycling of over 7 million pounds of CRTs (Exhibit 3-2).¹² The highest annual total of 3.7 million pounds came in the state's 2001 fiscal year when the largest number of communities received grants.

- About 60% of the recovery came through municipal programs (dropoff and curbside) with the remaining 40% through the PRFs.

- The PRF at the University of Massachusetts handled the most material, but the charities managed a significant quantity of material as well.

	Total Pounds To-Date	FY 2000	FY 2001	FY 2002
Municipal Programs or Contracts with State-Approved Haulers	4,314,000	735,000	2,583,000	996,000
Permanent Regional Facilities	2,711,000	679,000	1,136,000	896,000
Total Pounds Collected*	7,025,000	1,414,000	3,719,000	1,892,000

**From DEP database of grant recipient payments updated through early June 2002. FY2002 did not end until June 30, so that year's figures are incomplete.*

*** Excludes 14,000 pounds from other sources.*

¹² DEP also provided us with their grant database. This shows the payments to communities, haulers, and recyclers to cover recycling costs for communities eligible to receive assistance. It does not include all CRTs recovered in the state, nor can all the CRTs under the grant program be linked back to the town from which they originated because many of the payments to haulers and recyclers were for collections from multiple communities.

- Unfortunately, the data only cover communities receiving grants from the state. Many communities continue to operate their programs after the grants end, but their recovery totals are not reported. Similarly, many towns never received grants, but still recovered CRTs. The only way to document total recovery (including businesses) would be to obtain the data from recyclers and exporters.¹³
- Over time, the programs became more successful. Among the grant recipients, the average program effectiveness in pounds of CRTs per resident grew from 0.2 pounds in FY 2000 to 1.2 pounds in FY 2002 (Exhibit 3-3). The exhibit also indicates the range of effectiveness for the programs in these communities.
- The average size of communities receiving grants was 43,000 in 2000, influenced by the inclusion of Boston and some other larger cities. By 2002 the average had dropped to 22,000, much closer to the statewide average of 18,000.

Exhibit 3-3

Massachusetts Municipal CRT Recycling: Program Size and Effectiveness

	FY 2002	FY 2001	FY 2000
Communities Receiving Grants*	38	86	52
Population Served	820,000	3,234,000	2,243,000
Population per Program**	22,000	38,000	43,000
Pounds per Capita*** (range)	1.2 (0.38 – 2.9)	0.55 (0.02 – 6.95)	0.23 (0.04 – 3.6)

**Only municipalities listed in DEP's grants database*

***Includes Boston in 2000 and 2001*

****Underestimated because not all CRTs recovered through the grant program could be linked to the source community.*

¹³ This was beyond the scope of our analysis and probably impractical to obtain because of its proprietary nature.

Exhibit 3-4

Massachusetts Municipal CRT Recycling: Program Size and Effectiveness

	All Programs	Curbside Pickup	Ongoing Dropoff	Special Event Dropoff
Survey Respondents Reporting Tonnage	62	10	41	11
Population Served	2,120,000	1,080,000	840,000	200,000
Population per Program	34,000	110,000	20,000	18,000
Pounds per Year	2,400,000	1,300,000	960,000	210,000
Pounds per Capita (range) (median)	1.2 (0.1 – 9.3) (1.4)	1.2 (0.1 – 3.0) (0.9)	1.2 (0.2 – 9.3) (1.6)	1.0 (0.1 – 5.1) (2.0)

*From NERC 2001 survey of programs; 78 of the responses were from Massachusetts cities and towns
Note: Given the ranges over which data were reported, the uncertainty around the estimates is significant, but trends are still discernible from the data.*

3.3.2 Analysis of NERC Recovery Data

- A second source of data was a 2001 survey of electronics recycling programs conducted by the Northeast Recycling Council (NERC).
 - NERC surveyed 176 programs nationwide, but nearly half of the responses came from Massachusetts cities and towns. We focused our analysis on the responses from those Massachusetts communities.
 - The NERC survey contains much more detailed information about programs than the DEP data, but the quantitative data are less precise since many responses were reported as ranges. For example, annual recovery was reported in tons per year (1-5 tons, 5-10 tons, *etc.*). We adopted the convention of the NERC researchers and used the mid-point of the ranges for our quantitative analysis. Over a large sample the errors would tend to cancel each other out, but we should caution that the uncertainty around the estimates from the NERC data is significant.
- Data from the NERC survey were consistent with the DEP data with respect to the typical size of programs (34,000 residents each) and average effectiveness (1.2 pounds per capita) (Exhibit 3-4).
- We used the NERC data to compare effectiveness across different types of programs. As expected, curbside pickup was the primary means of collection in the larger communities.
 - The average community size with curbside pickup of CRTs was 110,000. Some of these communities also offered dropoff, but curbside was the primary method.
 - Dropoff programs, either special event or ongoing, serve much smaller communities averaging around 20,000 people.

- Average effectiveness was virtually the same across all three program types at 1.2 pounds per capita, but median and range data suggest that the typical dropoff programs offer higher recovery levels.
 - Median collections for dropoff programs were 1.6 and 2 pounds for ongoing and special event programs, but less than 1 pound for curbside.
 - The difference may be explained by the “clean out the attic” effect for dropoff programs, especially new ones.

3.3.3 *Statewide Recovery Estimate*

- Our best estimate for annual municipal CRT recovery is 7.2 million pounds (Exhibit 3-5).

- The estimate is derived from DEP and NERC data. Recovery of 1.2 pounds of CRTs per person is a conservative estimate (see discussion accompanying Exhibits 3-3 and 3-4.) With 6 million residents included in some type of program, we project municipal recovery is 7.2 million pounds per year.

- Most CRTs that enter the waste stream in Massachusetts should be recovered because of the disposal ban. Therefore annual generation of CRTs is probably between 7.2 and 8 million pounds. That is consistent with DEP’s estimate that 6 million pounds (3,000 tons) were disposed in 1998.

Exhibit 3-5

Massachusetts Municipal CRT Recycling: Statewide Estimate

Program Effectiveness*	Population with CRT Recovery Programs	Annual Recovery
1.2 lbs./capita	6 million	7.2 million lbs.

**See Exhibits 3-3 and 3-4*

- We also converted this weight data into an estimate of the number of units (TVs and computer monitors) recovered. Statewide, we estimate that 180,000 units are recovered, 110,000 TVs and 70,000 computer monitors.
 - This is only an estimate based on typical weight assumptions and an assumed mix of products being returned under the Massachusetts program.
 - We discussed the assumptions with product manufacturers and recyclers and determined that approximately 60% of the returned units are TVs and 40% are monitors. The average weight for TVs was set at 50 pounds and the average weight for monitors at 25 pounds, recognizing that the relative proportion and weights are likely to change over time.

3.4 Costs

3.4.1 Survey Data

- The NERC data allow us to examine costs to establish and operate municipal programs. While we caution against attributing too much precision to the data, the information is detailed and useful.
- Typical set-up costs for municipal programs are under \$1,000 and are somewhat higher for curbside programs (Exhibit 3-6).
 - The cost averages are influenced by some high outliers, but the median costs for both types of dropoff programs were less than \$1,000.
 - The median initial cost for curbside was between \$1,000 and \$5,000.

Exhibit 3-6

Massachusetts Municipal CRT Recycling: Program Costs

	All Programs	Curbside Pickup	Ongoing Dropoff	Special Event Dropoff
Program Set-Up Costs				
Average	\$2,400 (n=65)	\$2,400 (n=9)	\$2,300 (n=46)	\$2,900 (n=10)
Median	<\$1,000	\$1,000 - \$5,000	<\$1,000	<\$1,000
\$/ton	\$120/ton (n=54)	\$50/ton (n=8)	\$200/ton (n=39)	\$110/ton (n=7)
Program Operating Costs				
Average	\$9,700 (n=60)	\$17,000 (n=9)	\$7,000 (n=41)	\$1,400 (n=10)
Median	\$1,000 - \$5,000	\$5,000 - \$10,000	\$1,000 - \$5,000	\$5,000 - \$10,000
\$/ton	\$470/ton (n=51)	\$360/ton (n=9)	\$600/ton (n=36)	\$420/ton (n=6)

*From NERC 2001 survey of programs; 78 responses were from Massachusetts cities and towns.
Sample sizes from which estimates were derived are provided below each figure; the sample size for the
median is the same as for the average.*

- Start-up costs per ton are lower for curbside than for dropoff.
 - To adjust somewhat for the size of the program, we computed start-up costs per ton collected. Since start-up costs should be amortized over several years of operation, this is a somewhat misleading figure, but it helps calibrate the costs to the scale of the program.
 - Curbside costs were one-quarter to one-half the cost per ton for dropoff, which reflects the significantly higher quantity of material collected through the average curbside program (refer to Exhibit 3-4).
- Annual operating costs reflect the scale of the operations. Given the larger size of the curbside programs, their operating costs are also the highest.
 - On a per-ton basis, the operating cost data mirror the set-up cost data: the larger curbside programs have a lower cost per ton than dropoff: \$360/ton compared to \$600/ton for ongoing programs.
 - Much of this difference relates to the scale economy differences between the curbside programs in larger communities and the dropoff programs in smaller communities.
 - Scale economies permit more efficient handling and transportation. The curbside costs probably also reflect the use of more automation in handling and shorter transportation distances to recyclers (located near larger cities).
- We also expected to see increasing returns to scale across programs of the same type (*e.g.*, the largest dropoff programs would have the lowest costs per ton). This trend is generally supported by the NERC data, but the samples are too small and the uncertainty too substantial to draw many conclusions.

3.4.2 Statewide Cost Estimates

- Costs to establish municipal CRT recycling programs in Massachusetts total between \$430,000 and \$700,000 (Exhibit 3-7).

- Based on sample data, we computed statewide costs using both costs per program and costs per ton.

- Aggregate totals derived from costs per ton are lower because the largest programs (handling the most material) have the lowest cost per ton.

- Municipal operating costs which include payments for transportation and recycling range from \$1.7 million to \$2.8 million annually. The operating cost per household ranges from \$0.72 to \$1.20 per year.

Exhibit 3-7

Massachusetts Municipal CRT Recycling: Statewide Cost Estimates

	Assumptions	Totals
Program Set-Up Costs		
Using Program Averages (n=65)	\$2,400/program * 289 programs	\$700,000
Using Cost/Ton (n=54)	\$120/ton * 3,600 tons/year	\$430,000
Program Operating Costs		
Using Program Averages (n=60)	\$9,700/program * 289 programs	\$2,800,000
Using Cost/Ton (n=51)	\$470/ton * 3,600 tons/year	\$1,700,000

Based on NERC 2001 data. Sample sizes from which estimates were derived are provided in each row.

3.5 Impact of Charging Fees

- Beyond the issues of effectiveness and cost, a critical policy question is how the programs are funded. We analyzed the NERC data to see how fees affect cost and effectiveness.
- 55% of communities in the NERC database and 38% of communities in the DEP data charged fees at the time the surveys were conducted. There is a trend toward more communities charging fees in the future. Fees for CRTs typically ranged from \$5 to \$10 with higher amounts sometimes charged for larger TVs and consoles.
- There is no correlation between the size of a community and whether or not it charges a fee.
 - The median program size is around 16,000 residents in the NERC data for communities charging a fee and 17,000 for those that do not – an insignificant difference (Exhibit 3-8).
 - The averages do vary, but that is because of the influence of larger cities, particularly Boston, in pulling up the average size.
- The same holds true for dropoff programs – average and median program sizes are similar in fee and no-fee programs. No-fee curbside programs are more common in larger cities, but we should note that some of the charity dropoffs in those cities do charge fees.

Exhibit 3-8

Massachusetts Municipal CRT Recycling: Impact of Charging Fees

	All Programs	Charge Fee	No Fee Charged
Demographic Comparison			
Average Population Served (n=76) (Median)	32,000 (16,000)	22,000 (16,000)	45,000 (17,000)
Ongoing Dropoff (n=52) (Median)	20,000 (14,000)	19,000 (13,000)	22,000 (15,000)
Curbside (n=11) (Median)	103,000 (42,000)	37,000 (35,000)	219,000 (140,000)
Pounds per Capita Collected			
All Types of Programs (n=62) (Median)	1.2 (1.4)	1.1 (1.2)	1.2 (1.5)
Ongoing Dropoff (n=41) (Median)	1.2 (1.6)	1.4 (1.6)	0.9 (1.1)
Curbside (n=10) (Median)	1.2 (0.9)	0.7 (0.4)	1.3 (1.5)
Costs per Ton			
Setup Costs – All Programs (n=54)	\$120	\$200	\$80
Operating Costs - Ongoing Dropoff (n=36)	\$600	\$550	\$800

From NERC 2001 survey; 78 of the responses were from Massachusetts cities and towns.

- While effectiveness does not vary significantly based on fee practices for all programs, there is a difference if we examine dropoff and curbside separately.
- Ongoing dropoff programs that charge fees collect more material per capita than those that do not. This is counter to the expectations of many that charging a fee at the point of disposal discourages recovery.
- Conversely, curbside programs that charge fees appear to collect less than those that do not.¹⁴ The fees may discourage some residents from calling for pickup. Also, the large cities that do not charge fees offer both curbside pickup and PRF dropoff. This increases the tonnage in these communities. Unfortunately the data do not permit us to distinguish tonnage from different types of collection programs within a community.
- Program set-up costs are significantly higher for programs that charge fees. It may be that communities developing costlier, more elaborate programs are more likely to seek to recover those costs through the use of fees. The effectiveness data suggest that the programs that charge fees do achieve higher recovery rates and it may be because more money is spent to develop and promote them.
- The only other cost category where there was a significant difference based on fee practices was operating costs for ongoing dropoff programs. Programs that charge fees had lower operating costs per ton, again probably because they are handling higher volumes of material and achieving greater scale economies.

¹⁴ Note that the sample sizes for curbside are quite small so the differences may not be statistically significant.